Accurate CV/CC Primary Side Converter

1 Description

Adopting the primary side voltage and current sampling technology, CN1611 simplify the CV/CC mode switching power supply design without optical coupling and secondary side control circuit, but also has accurate output voltage and current regulation.

CN1611 can realize 75mW standby power consumption, high efficiency and no noise in multiple operation modes. Frequency jitter technology can greatly reduce the cost of EMI filter. The CN1611 of DIP-7 package can be adjusted accurately CV/CC, which has the advantages of low cost and high reliability. At the same time, it provides rich protection functions: It includes cycle by cycle peak current limitation, VCC under voltage locking (UVLO), over voltage protection (OVP) and clamping. When fault occurs, the controller still try soft restart until the fault condition is eliminated.

CN1611 provides DIP-7 package, with built-in MOSFET with withstanding voltage up to 1000V, to ensure reliable operation of the product in harsh power supply environment.

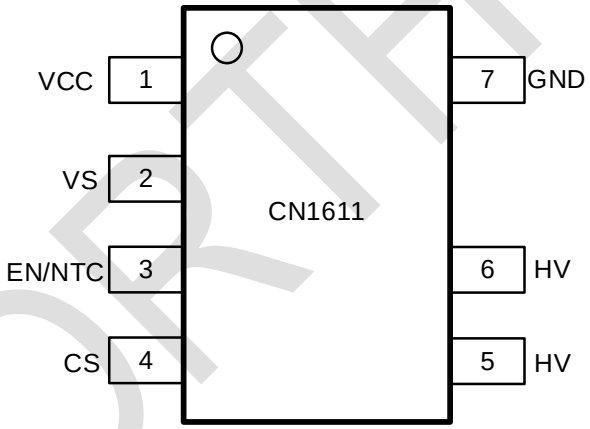
2 Features

- CV/CC adjustment error ±5%
- Control circuits without optical coupling and all secondary CV/CC component
- Quasi resonant working mode
- Built-in line compensation for more precise CC regulation
- Lead Edge Blanking (LEB)
- Periodic Current Limit
- VCC undervoltage locking (UVLO) with hysteresis
- Built-in short circuit protection and output overvoltage protection
- Built-in over-temperature protection
- Output power up to 15W

3 Applications

- Industrial Instrument: Single-phase watt-hour meter/three-phase watt-hour meter
- Outdoor monitoring/protection equipment
- AC-DC of high input volt

4 Pinout



5 Ordering information

Product Number	Package	Quantity/Tube
CN1611	DIP-7	50/Tube

6 Marking

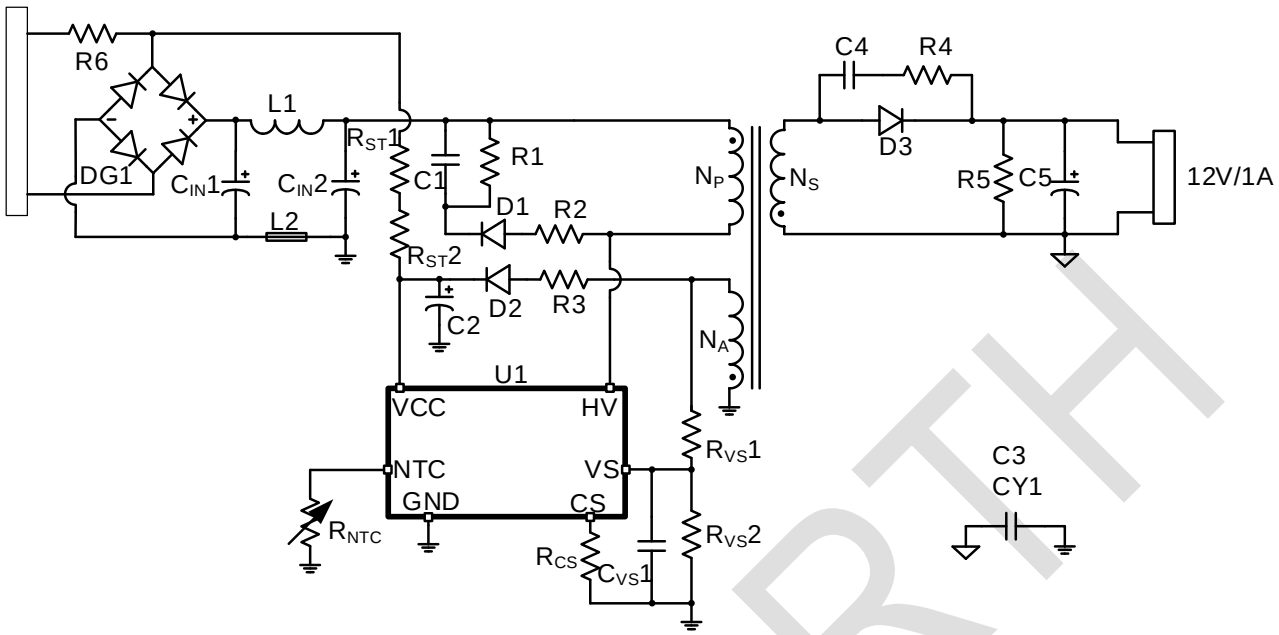
Product Number	Marking
CN1611	CN1611 YYWWHT

Note: YY=Year, WW=Week, HT is the packaging plant code and is fixed.

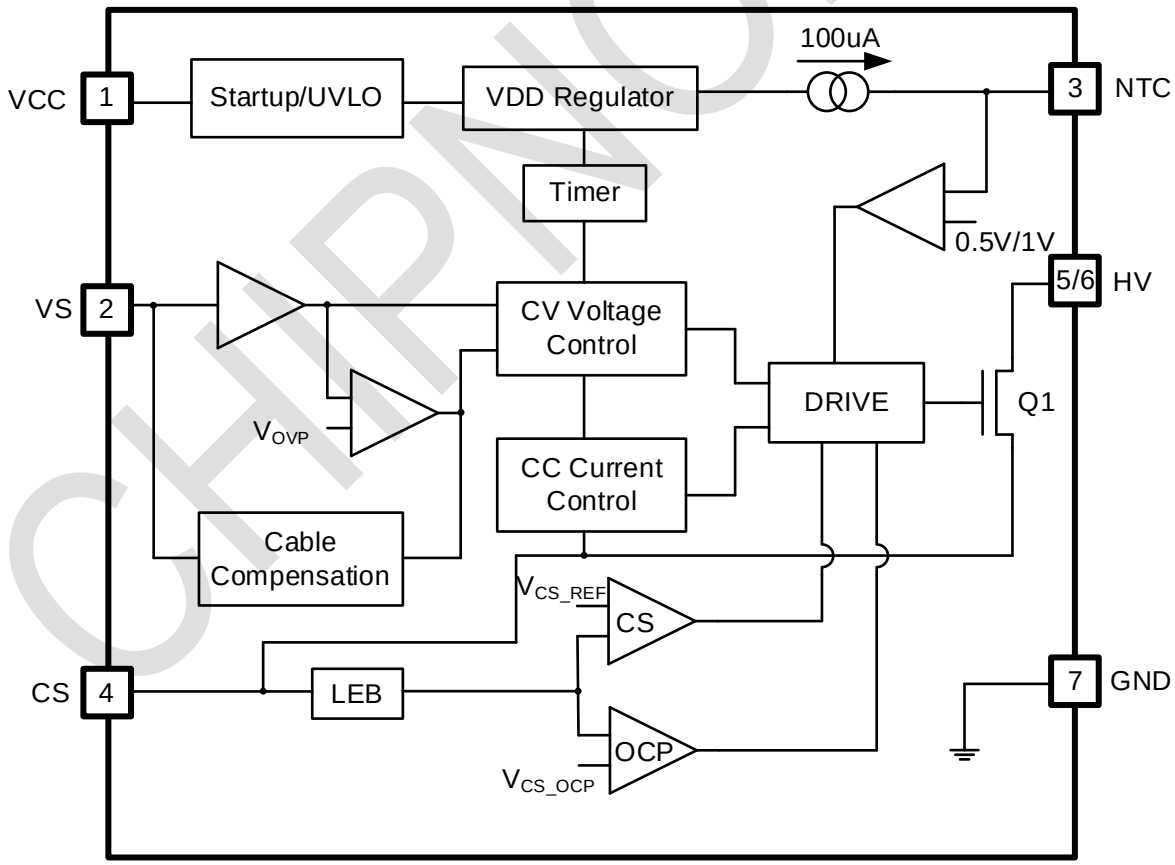
Green (RoHS & HF): CHIPNORTH defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your CHIPNORTH representative directly.

Moisture sensitivity level(MSL):3

7 Typical Application



8 Block Diagram



9 Pin Descriptions

Pin No.	Pin Name	Descriptions
1	VCC	Chip supply power input pin
2	VS	The auxiliary winding voltage sampling input pin is connected with the auxiliary winding through resistance
3	EN/NTC	Enable control pin to connect to ground NTC resistor or low level off control
4	CS	connected to the power MOSFET source stage. Primary current sampling input
5,6	HV	Connected to power MOSFET drain level
7	GND	Chip Reference ground

10 Specifications

10.1 Absolute Maximum Ratings

Parameter	Symbol	Value	Units
Chip supply power input voltage	VCC	-0.5~40	V
Feedback voltage sampling input	VS	-30~6	V
Current sampling pin ground voltage	CS	-0.5~6	V
Enable control	EN/NTC	-0.5~6	V
Power MOSFET drain voltage	HV	-0.5~1000	V
Ambient temperature	T_A	-40~105	°C
Storage temperature	T_{STG}	-55~150	°C
Welding temperature	T_{LEA}	260 (soldering, 10s)	°C

Note: The limit parameter is a threshold that can not be exceeded under any condition (even an instant). Once the chip runs beyond the limit parameters, it may cause aging or permanent damage. The limit parameter only emphasizes numerical values and does not necessarily indicate that the chip can work properly under these limits.

10.2 ESD Ratings

Discharge mode	Standard	Value	Units
HBM	ESDA/JEDC JDS-001-2014	±4000	V

10.3 Electrical Characteristics

Test conditions: TA=25°C, unless otherwise specified

Parameters	Symbol	Test conditions	Value			Unit
			Min	Typ	Max	
Power supply (VCC pin)						
VCC Overpressure	V_{CC_OVP}		33	36	39	V
Protection	I_{CC}	V_{CC}=V_{ST}-1V	240	300	360	μA
Static current @ no load	V_{ST}		10.8	12.8	14.8	V
Start-up voltage	V_{CC_MIN}		6.8	7.5	8.2	V
Minimum operating voltage	I_{ST}	V_{CC}=V_{ST}-0.5V		0.1	0.6	μA
Voltage control (VS pin)						
VS reference voltage	V_{VS}		1.97	2.0	2.03	V
Minimum break time	T_{MIN}			1.5		mS
Current control (CS pin)						
Turn-off voltage @ full load	V_{CS_MAX}		580	600	620	mV
Off voltage @ light load	V_{CS_MIN}			200		mV
Front blanking time	T_{LEB}			600		nS
Secondary maximum duty cycle	D_{MAX}		0.47	0.50	0.53	
Protection function						
Over-temperature protection	T_{OTP}		130	150		°C
Overtemperature hysteresis temperature				30		°C
NTC thermal protection off voltage				0.5		V
NTC thermal protection recovery voltage				1.0		V
NTC pull up current				100		μA
Output overvoltage protection	V_{VS_OVP}		2.2	2.5	2.8	V
Short-circuit voltage	V_{VS_HICCUP}		0.7	0.85	1	V
Power tube (HV pin)						
Breakdown voltage	BV_{DSS}	I_{DSS}=250uA	1000			V
on-resistance	R_{DS_ON}	V_G=10V, I_D=1A		7.8	8	Ω

11 Detailed Description

11.1 Overview

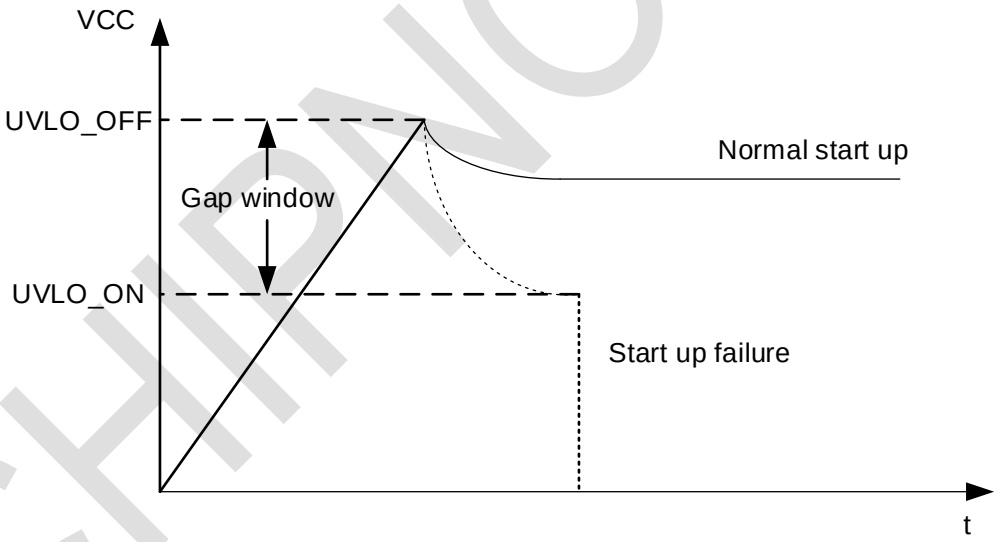
CN1611 is an innovative AC-DC controller that employs proprietary primary side control technology to eliminate the optocoupler isolated feedback and secondary control circuits required in traditional design. effectively improve cost effectiveness and enhance reliability. furthermore, CN1611 used some new technologies to further improve the performance.

11.2 Function Description

11.2.1 Start

When the system circuit built by CN1611 is powered on, the voltage of the energy storage capacitor of VCC pin can be charged to be higher than UVLO (off) through the starting resistance (> 6m Ω) with large resistance value, so that CN1611 can be started and reach the normal working state.

The starting process is as follows: in the initial stage of starting, the starting current consumed by cn1611 is supplied by the starting resistor to charge the VCC pin energy storage capacitor. When the voltage of the VCC pin energy storage capacitor is charged from the starting resistor to the starting voltage of the chip (UVLO off), the chip starts to start, thus starting from the VCC in an instant Pin energy storage capacitor draws current, then CN1611 starts to vibrate, and the system starts to operate. In no abnormal state, the energy storage capacitor of VCC pin changes to supplement energy from auxiliary coil, and then maintains a normal working voltage. For details, please refer to CN1611 startup sequence diagram in Figure.



11.2.2 Constant (CV) mode

In order to achieve accurate output voltage regulation, it is necessary to detect the change of output and load. The vs pin of cn1611 detects the feedback signal of the auxiliary winding through rvs1 and rvs2. During power on, the power output voltage vs is mapped to the auxiliary coil turns ratio of N_{AUX}/ N_S. The voltage can be expressed as:

$$V_{AUX} = V_s * N_{AUX}/N_S$$

Among them, N_{AUX} is the number of turns of the auxiliary winding and N_S is the number of turns of secondary output.

During power off, the voltage of the secondary winding is mapped to the auxiliary winding, denoted as:

$$V_{AUX} = (V_O + V_D) \times \frac{N_{AUX}}{N_S}$$

Among them, NS are turns of secondary windings, V_D is the voltage drop of the rectifier diode.

In the typical application diagram, the auxiliary winding voltage V_{AUX} is sent to the vs pin of CN1611through Rvs1 and Rvs2. Compared with the reference voltage V_{VS} inside the chip, the duty cycle is adjusted to keep the output voltage constant.

The adjusted final output voltage is equal to:

$$V_O = \frac{N_S}{N_{AUX}} \times V_{VS} \times \left(1 + \frac{R_{VS1}}{R_{VS2}}\right) - V_D$$

Where the internal reference voltage V_{VS} equal to 2V (typical values)

11.2.3 Constant current (CC) mode

The chip detects the peak current of the transformer on a periodic basis. The CS terminal is connected to the input of the internal peak current comparator to compare with the internal threshold voltage. When the CS external voltage reaches the internal detection threshold, the power tube is turned off.

The expression of peak inductance current at full load is as follows:

$$I_{P\_PK} = \frac{V_{CS}}{R_{CS}}(mA)$$

There is one 600nS leading edge blanking function in comparator.

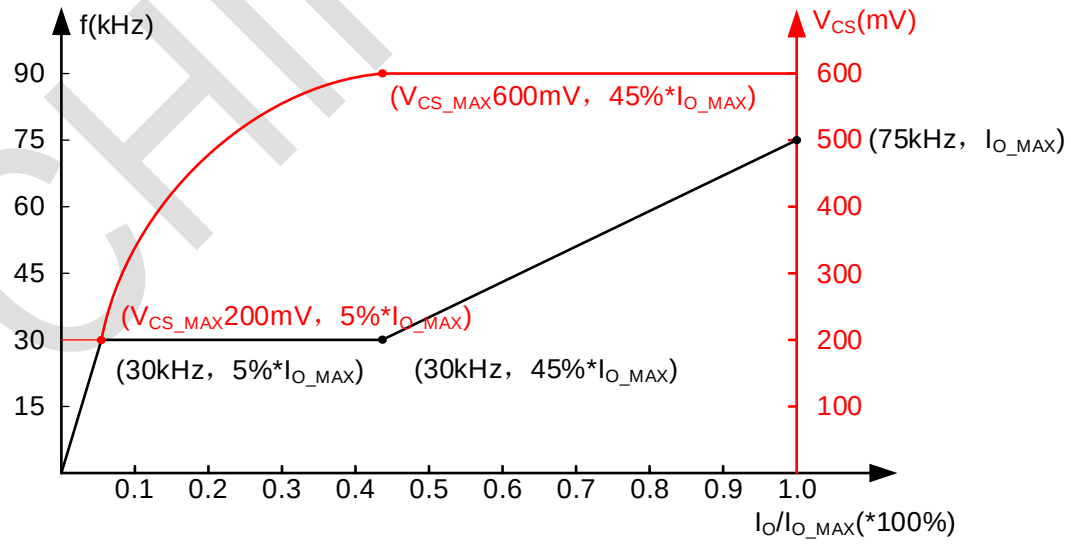
Output current calculation formula:

$$I_O = \frac{1}{4} \times I_{P\_PK} \times \frac{N_P}{N_S}$$

Among them N_P is the number of turns of the main stage of the transformer, N_S is the number of turns of the secondary stage of the transformer, I_{P_PK} is the peak current on the main stage side.

11.2.4 PWM/PFM mixed mode

In order to make a trade-off between efficiency, no-load and standby, noise, ripple and other different characteristics, CN1611 adopts PWM/PFM hybrid mode. In constant voltage (CV) mode, CN1611 system works in pure PWM mode from medium load to full load; from medium load to no load, the system operates in mixed PWM/PFM mode. The figure shows the trend of frequency and output current after load change.



f_{OSC} and I_O Relation to load

11.2.5 Protection function

CN1611 integrated complete protection features including built-in OVP, OTP, UVLO, OCP, output short/open protection and open loop protection.

CN1611 is able to monitor the primary measured peak current through the CS pin.CN1611 allows control and limitation of the cycle-by-cycle peak current. When the voltage of the CS pin reaches the internal OCP threshold, the overcurrent is detected by CN1611 and the power MOSFET switch is turned off immediately until the next pulse is generated.

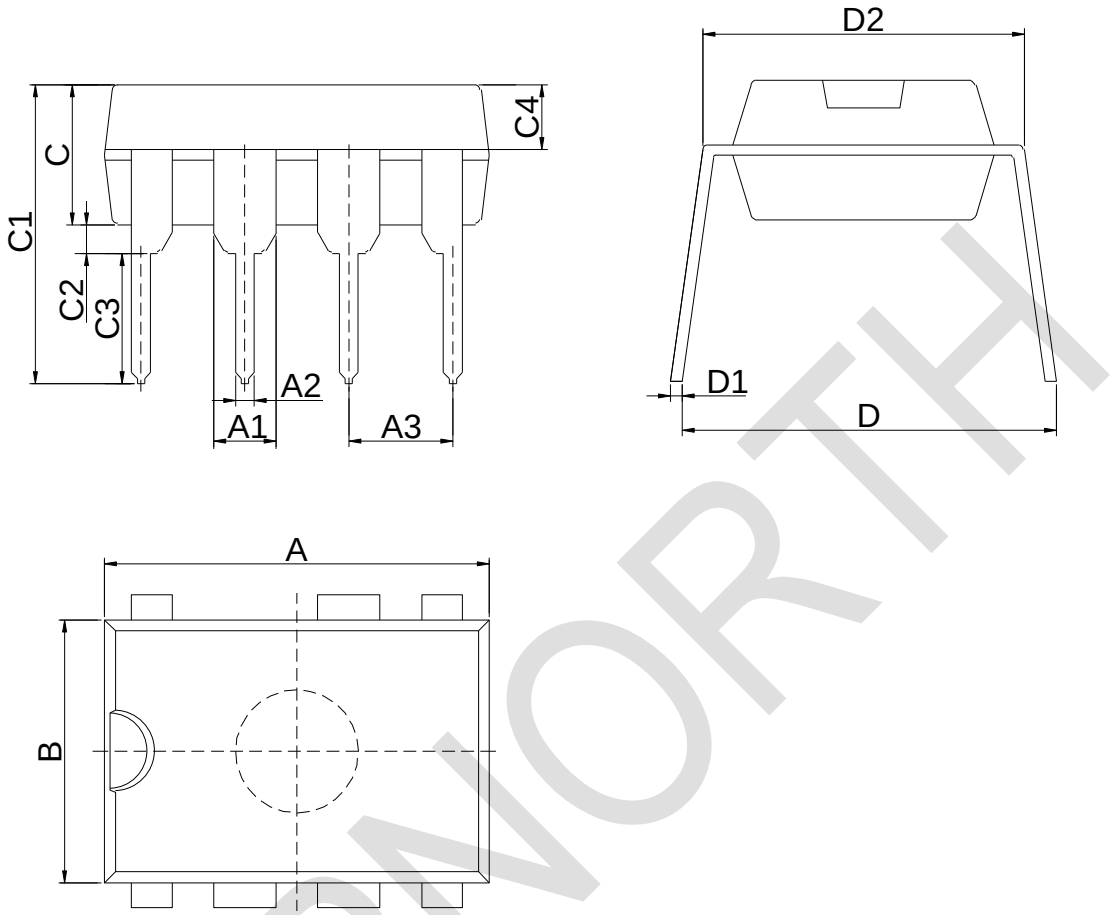
VCC protection is achieved by UVLO and OVP. When the VCC voltage drops below the UVLO (on) threshold or rises above the OVP threshold and the power system enters the automatic restart sequence. The output of the CN1611 is turned off. In case of output short circuit or disconnection, UVLO (on) and OVP can also be triggered, and CN1611 can be shut down and enter the automatic restart sequence.

Over temperature protection (OTP) circuit detects chip temperature. OTP threshold is usually set at 150°C. When the chip temperature rises above the threshold. The device turns off and enters the automatic restart sequence.

In case of open loop, CN1611 can detect the fault status, close and enter the automatic restart sequence.

12 Package Information

DIP-7



Dimension / Symbol	Min (mm)	Nom (mm)	Max (mm)
A	9	-	9.4
A1	1.524BSC		
A2	0.33	-	0.51
A3	-	2.54	-
B	6.2	-	6.6
C	3.2	-	3.6
C1	0.24	0.25	0.26
C2	0.51	-	-
C3	3	-	3.6
C4	1.55	1.6	1.65
D	7.62	-	9.3
D1	0.204	-	0.36
D2	7.62REF		

13 Important Statement

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